



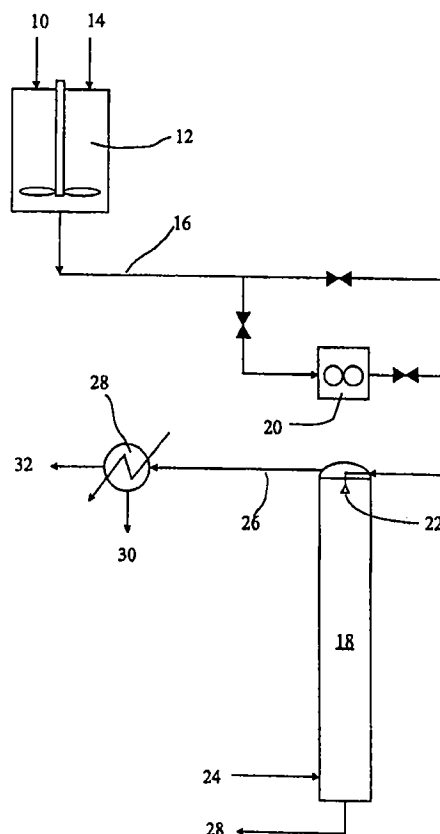
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(54) Title: COFFEE AROMA RECOVERY PROCESS AND AROMA PRODUCT

## (57) Abstract

A process for the recovery of aroma components from coffee. A slurry of coffee grounds in an aqueous liquid is subjected to stripping for stripping aroma components from the slurry. The stripping is carried out using gas in a substantially counter-current manner to provide an aromatised gas containing aroma components. The aroma components are then collected from the aromatised gas. The aroma components may be added to concentrated coffee extract prior to drying of the extract. The coffee powder produced has much increased and improved aroma and flavour and contains higher levels of furans and diketones.



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## COFFEE AROMA RECOVERY PROCESS AND AROMA PRODUCT

This invention relates to a process for the recovery of coffee aroma prior to extraction and to the aroma so recovered. The recovered aroma is useful for  
5 aromatising instant coffee.

Aromas are an important part of many products since consumers associate certain aromas with certain products. If the product lacks the aroma associated with it, consumer perception of the product is adversely affected. This is particularly a problem in the field of instant coffees, although it also exists in  
10 other fields. Instant coffee powders which are obtained from commercial processes involving extraction, concentration and drying, are usually substantially aroma-less. For this reason, it is conventional to recover coffee aromas which are given off during the processing of the instant coffee and to reincorporate these aromas into the concentrated coffee extract prior to drying or  
15 into the instant coffee powder.

The coffee aromas are recovered at several points during processing of the instant coffee and most commonly during grinding of the roasted beans and by steam stripping of the coffee extract prior to concentration and drying of the coffee solids.

The recovery of aroma from ground coffee is disclosed in US patent  
20 3535118. This patent discloses a process in which roast and ground coffee is placed in a column and maintained at about 40°C. The bed of coffee is then moistened by spraying water on it to assist in displacing aromas from the coffee particles. An inert gas, usually nitrogen, is heated to about 44°C and introduced  
25 into the column from beneath the bed. As the inert gas passes up through the bed, it strips the aromas from the coffee particles. The inert gas is then fed to a condenser which is operated at a temperature of about 5°C to condense water in the inert gas. The de-watered inert gas is ultimately fed to a cryogenic condenser to condense the aroma as a frost. The frost is then recovered.

Another process for recovering aroma from roast and ground coffee is  
30 described in international patent application WO 97/10721. In this process, the ground coffee is transported through an elongated mixing zone while being agitated. At the same time, an aqueous fluid is sprayed into the elongated mixing zone to moisten the ground coffee as the ground coffee is being  
35 transported and agitated. A aroma gases released by the moistened ground coffee

in the elongated mixing zone are drawn off and are collected. Similar processes are described in UK patent 1466881 and US patent 4092436.

One of the problems perceived to arise with these processes is that they result in pre-wetting of the coffee grounds outside of the extraction cell or column. According to Sivetz, M and Desrosier N.W.; 1979; Coffee Technology, AVI Publishing Company, Inc., page 334, this practice is bad because it "causes staling of ground coffee in less than an hour, accompanied by a heavy, undesirable flavor and a loss in natural coffee volatiles". Sivetz and Desrosier strongly advocate that first wetting of the coffee grounds should occur in the extraction cell or column. Consequently recovery of aroma from ground coffee by pre-wetting it is not common practice; despite ground coffee being a good source of aroma.

Further, not all components of the aroma obtained in a cup of freshly brewed coffee are captured during pre-wetting. Consequently, unless further aroma is captured later during the process, some aroma components are lost; components which would, if incorporated into instant coffee powder, improve the aroma of a beverage prepared from the instant coffee powder. Further, many of the conventional recovery techniques damage or alter the aroma components.

Therefore there is still a need for a process for recovering aroma from ground coffee.

Accordingly, in one aspect, this invention provides a process for the recovery of aroma components from coffee, the process comprising:  
providing a slurry of coffee grounds in an aqueous liquid;  
stripping aroma components from the slurry using gas in a substantially counter-current manner for providing an aromatised gas containing aroma components; and

collecting the aroma components from the aromatised gas.

The process provides the advantage that significantly larger amounts of aroma components may be stripped from the coffee than is the case with conventional processes. Further, since the aroma components are stripped from the coffee prior to extraction, thermal degradation of the aroma is reduced to a minimum. Also, these aroma components may be readily reincorporated to provide a soluble coffee product which has increased and improved aroma and flavour.

The slurry of coffee grounds may be provided by slurrying roasted and ground coffee with the aqueous liquid, or by slurrying whole coffee beans with

the aqueous liquid and then subjecting the coffee beans to grinding. The coffee grounds preferably have an average particle size in the range of about 1 mm to about 3 mm.

5 The process preferably further comprises the steps of adding the collected aroma components to a concentrated coffee extract and drying the coffee extract to powder for providing an aromatised soluble coffee powder.

The process may further comprise the step of concentrating the collected aroma components.

10 The aroma components may be collected by subjecting the aromatised gas to one or more condensation operations. Preferably, in a first operation, the aromatised gas is subjected to condensation at a temperature in the range of about 0°C to about 98°C and, in a second operation, the aromatised gas is subjected to cryogenic condensation at a temperature of less than about -80°C. The first operation may be carried out in one or more steps. For example, the aromatised  
15 gas may be subjected to condensation at a temperature in the range of about 80°C to about 95°C and, in a second step, at a temperature in the range of about 0°C to about 10°C. Alternatively, the aromatised gas may be subjected to condensation at a temperature in the range of about 20°C to about 50°C.

20 Preferably the aroma components are stripped from the slurry in a disc and donut stripping column. The gas used to strip the aroma components is preferably low pressure gas; for example steam at a gauge pressure of less than about 100 kPa.

25 In another aspect, this invention provides an aromatised, spray-dried soluble coffee powder which comprises least about 0.35 equivalent µg/g furans and at least about 0.25 equivalent µg/g diketones.

In yet another aspect, this invention provides an aromatised, freeze-dried soluble coffee powder which comprises least about 0.60 equivalent µg/g furans and at least about 0.40 equivalent µg/g diketones.

30 The invention also provides aromatised soluble coffee powders produced by the processes defined above.

Embodiments of the invention are now described, by way of example only, with reference to the drawing which is a schematic flow diagram of an aroma recovery process.

35 Referring to Figure 1, roasted coffee 10 is introduced into a mixing tank 12. The mixing tank 12 is sealed to prevent aroma loss. Alternatively, any aroma components escaping from the mixing tank 12 should be collected; for example

by directing the aroma components to a condenser. The coffee 10 may be in the form of whole beans or may be ground. If ground coffee is used, the particle size of the coffee is preferably in the range of about 1 to about 3 mm. Roasted coffee surrogates, such as chicory, may also be added to the mixing tank 12. An aqueous liquid 14 is also introduced into the mixing tank 12 in order to slurry the coffee 10. The aqueous liquid 14 is conveniently water or coffee extract obtained from a downstream extraction operation. The use of coffee extract is preferred. The temperature of the aqueous liquid 14 is preferably in the range of about 20°C to about 99°C; for example about 80°C to about 99°C.

10       The amount of aqueous liquid used to slurry the coffee 10 is not critical but is suitably sufficient such that the solids content of the resulting slurry 16 is about 1% to about 30% by weight. A solids content of about 5% to about 15% by weight is preferred.

15       The slurry 16 is transported to the top of a stripping column 18. If the coffee in the slurry 16 was not ground prior to forming of the slurry 16, the slurry 16 is diverted to a wet grinder 20 prior to being transported to the stripping column 18. The whole beans in the slurry 16 are then ground in the wet grinder to a suitable particle size; for example in the range of about 1 to about 3 mm. Any suitable wet grinder 20 may be used. Suitable slurry pumps (not shown) are used to transport the slurry 16 to the stripping column 18.

20       The temperature of the slurry 16 prior to being introduced into the stripping column 18 is preferably above about 90°C. This may be achieved by using an aqueous liquid 14 at a temperature above about 90°C or by subjecting the slurry 16 to heating; preferably indirect heating.

25       The slurry 16 is introduced into the stripping column 18 through a suitable distributor 22 and flows downwardly through the stripping column 18. A stripping gas 24, conveniently steam but which may also be nitrogen, carbon dioxide or mixtures of steam, nitrogen, and carbon dioxide, is introduced into the stripping column 18 adjacent the bottom of the stripping column 18. The stripping gas 24 flows upwardly through the stripping column 18, substantially counter-current to the slurry. As the stripping gas 24 flows through the stripping column 18, it strips and transports aroma components from the coffee in the slurry. A gas stream 26 made up of the steam, gas liberated from the coffee, and transported aroma components is removed from the top of the stripping column 35 18. A stripped slurry 28 is removed from the bottom of the stripping column 18.

The amount of stripping gas 24 used to strip the aroma components from the slurry 16 may be selected as desired within the constraints of the type of stripping column 18 selected. Strip rates of about 5% to about 100% by weight of steam to dry coffee introduced may be suitable. For lower stripping rates, for example about 10% to about 20%, the total amount of aroma components removed from the slurry is less. However less moisture, which may dilute the coffee extract produced downstream when the aroma is recombined with the extract, is collected. The pressure of the steam used is preferably below about 100 kPa (gauge); for example below about (20 kPa gauge). The water used to generate the steam is preferably subjected to de-oxygenation prior to being formed into steam. If desired, inert carrier gases such as nitrogen may be introduced into the stripping column along with the stripping gas 24.

Any suitable stripping column 18 may be used; packed or plate. Suitable stripping columns are well known in the art and the skilled person may readily select a suitable column depending upon the process conditions and fluid characteristics. However, it is found that disc and donut columns operate reasonably well, particularly since they are less susceptible to plugging.

The gas stream 26 leaving the top of the stripping column 18 is then processed to capture the aroma components. This may be carried out using conventional techniques. For example, the gas stream 26 may be led to a condenser system 28. The condenser system 28 is operated at a temperature sufficiently low to condense most of the aroma from the gas stream 26. A temperature of below about 50°C is suitable although cooling to below 30°C is preferred. Preferably more than one condenser is used; each succeeding condenser being operated at a lower temperature than the previous condenser. Preferably the downstream most condenser is operated at a temperature of about 0°C to about 10°C.

If it is desired to concentrate the aroma components using partial condensation, the gas stream may be subjected to a first condensation step at a high temperature; for example at about 80°C to about 95°C. This will result in the condensation of primarily water. The non-condensing and concentrated aroma components may then be subjected to a second condensation step at a lower temperature; for example at about 0°C to about 50°C to provide the aroma liquid 30.

The aroma liquid 30 removed from the condenser system 28 contains aroma components which may be used to aromatize coffee extract as explained below.

Aroma components 32 which do not condense in the condenser system 28 may be directed to a cryogenic aroma condenser (not shown) for collection. Many suitable cryogenic aroma condensers are known and have been reported in the literature. However, a particularly suitable cryogenic aroma condenser is described in US patents 5182926 and 5323623; the disclosures of which are incorporated by reference. Further details of the operation of this cryogenic aroma condenser may be obtained from the disclosures in the patents. Plainly other cryogenic aroma condensers may be used; for example that disclosed in US patent 5030473. The aroma collected in the cryogenic aroma condenser is in the form of a frost. The frost may be used to aromatise coffee extract as explained below. Alternatively, the frost may be combined with a suitable carrier substrate such as coffee oil or an emulsion containing coffee oil. This aromatised carrier is conveniently added to the soluble coffee powder finally produced.

The stripped slurry 28 leaving the bottom of the stripping column 18 is transported to an extraction system (not shown). The extraction system may be any suitable system since this aspect is not critical to the invention. Suitable extraction systems include batteries of fixed bed cells, plug flow reactors, moving bed reactors and the like. During the extraction process, the coffee grounds may be subjected to one or more thermal solubilisation steps.

The coffee extract leaving the extraction system is then concentrated as is conventional. However, some of the coffee extract may be used as the aqueous liquid 14 instead of being concentrated. The aroma liquid 30 removed from the condenser system 28 may then be added to the concentrated extract. If desired, the aroma components in the aroma liquid 30 may be concentrated prior to being added to the concentrated extract. This may be necessary to avoid dilution of the concentrated extract if higher stripping rates were used in the stripping column. Concentration may be carried out using conventional procedures such as partial condensation, rectification, membrane concentration and freeze concentration.

Also, the frost obtained from the cryogenic aroma collector may be added to the concentrated extract. The aromatised extract is then dried in the usual manner to provide an aromatised, soluble coffee powder; for example by spray- or freeze-drying. Of course, the aroma liquid 30 and aroma frost may be used for other aromatisation purposes.

It is found that the process results in an aromatised coffee powder which has much more aroma and flavour than produced by conventional techniques.



When dissolved in hot water, the powder provides a product which has increased flavour and aroma strength; especially in coffeeness, body and roastiness.

In particular, the coffee powder products contain higher amounts of furans and diketones than conventional coffee powder products. Furans and diketones  
5 contribute to the aroma and flavour of beverages produced from the coffee powder products to improve the beverages.

When produced by spray drying, the coffee powder products contain at least about 0.30 equivalent  $\mu\text{g/g}$  furans and at least about 0.25 equivalent  $\mu\text{g/g}$  diketones. Preferably, the coffee powder product further contains at least about  
10 0.02 equivalent  $\mu\text{g/g}$  of each of 5-methylfurfural and 2,3-hexanedione. More preferably, the coffee powder products at least about 0.04 equivalent  $\mu\text{g/g}$  of 2,3-hexanedione.

When produced by freeze drying, the coffee powder products contain at least 0.60 equivalent  $\mu\text{g/g}$  furans and at least 0.40 equivalent  $\mu\text{g/g}$  diketones.  
15 Preferably, the coffee powder product further contains at least 0.02 equivalent  $\mu\text{g/g}$  of each of 5-methylfurfural and 2,3-hexanedione. More preferably, the coffee powder products contains at least about 0.65 equivalent  $\mu\text{g/g}$  furans, at least about 0.04 equivalent  $\mu\text{g/g}$  of each of 5-methylfurfural, 2-methyl-pyrazine and 2,3-hexanedione.

In this specification, the term "Furans" means compounds of the furan class including furan, 2-methylfuran, 3-methylfuran, 2,5-dimethylfuran, 2-vinylfuran, dihydro-2-methyl-3(2H)furanone, 2-furancaboxaldehyde, 2-vinyl-5-methylfuran, 2-furanemethanol, 5-methylfurfural, 2-furanmethanol acetate, 2-  
20 [(methylthio)methyl]furan, 2,2'-methylenebisfuran, and 1-(2-furanylmethyl)-1H-pyrrole.  
25

The term "Diketones" means compounds of the diketone class including 2,3-butanedione, 2,3-pentanedione and 2,3-hexanedione.

The term "equivalent  $\mu\text{g/g}$ " means equivalent  $\mu\text{g}$  of methyl butyrate per g of roast and ground coffee.

Specific examples of the invention are now described to further illustrate the invention. In the examples, aroma components are analysed using gas chromatography and mass spectrometry. The aroma components are introduced into the gas chromatograph using a purge and trap method. The components separated in the gas chromatograph are detected using a mass spectrometer. The  
30 conditions of the gas chromatograph and mass spectrometer are as follows:  
35

Column	Restek RTX-1 60m x 0.25mm x 1.0 $\mu$ m
Flow rate	20 ml/minute in He carrier gas
Split ratio	20:1
Initial temperature	35°C
Initial hold time	1 minute
Temperature increase rate	4°C per minute
Final temperature	230°C
Solvent delay	0 minutes
Scan range	35 to 260 amu
Electron energy	70 volts.

All results are expressed in equivalent  $\mu$ g of methyl butyrate per g of roast and ground coffee.

5 The detection limits of the analytical procedure for certain of the compounds are as follows:-

Compound	Detection limit
2-methylpyrazine	0.02
2,3-hexanedione	0.02
5-methylfurfural	0.02

Of course it is possible that lower amounts of these compounds may be detected using other techniques.

10

### Example 1

Roast and ground coffee is fed into a slurry tank at a rate of about 2.7 kg/minute. The roast and ground coffee has an average particle size of about 1.4 mm. A coffee extract containing about 8 to 10% by weight of soluble coffee solids is also fed into the slurry tank at a rate of about 27 kg/minute.

15 The resulting slurry is fed to the top of a disc and donut stripping column using a slurry pump. The column has 12 stages. The internal diameter of the column is 23 cm and the height of each stage is 20 cm. Steam at a low pressure of less than about 20 kPa (gauge) is fed into the bottom of the stripping column. The flow rate of the steam is varied to provide a range of stripping rates between 20 15% and 90% by weight of steam compared to roast and ground coffee.

The aromatised gas stream leaving the stripping column is condensed in a condenser operating at about 20°C. The condensed liquid is collected and analysed for aroma components. The uncondensed gas is transported to a cryogenic aroma collector operated as described in US patent 5,182,926. The  
5 aroma frost collected in the cryogenic aroma collector.

The stripped slurry leaving the stripping column is then subjected to extraction in a continuous extraction system made up of three extraction reactors and two solubilisation reactors. The yield is about 50 to 53% by weight. The extract obtained is concentrated to provide a concentrated extract containing above about  
10 40% by weight of soluble coffee solids.

The condensed liquid from the condenser is added to the concentrated extract and the extract is dried to soluble powder in a spray-drying tower. The process is repeated except that the frost from the cryogenic aroma collector is also added to the concentrated extract.

15 A teaspoon of each soluble powder is dissolved in 150 ml of hot water at 85°C. All beverages produced have a brew-like flavour and aroma with good coffeeness, acidity, body and roastiness. The beverages produced from soluble powder produced at higher stripping rates have more flavour and aroma. The beverage produced from the soluble powder having the frost added to it has  
20 perceivably more above-the-cup aroma and roastiness.

### Example 2

The process of example 1 is repeated except that whole roasted beans are  
25 fed into the slurry tank. The resulting slurry is then fed to a wet, in-line grinder in which the beans are ground to an average particle size of about 2.4 mm. The slurry is then transported to the stripping column. The stripping rate in the column is 90% by weight of steam compared to roast and ground coffee. The aromatised gas stream leaving the stripping column is then subjected to  
30 concentration by rectification in a packed rectification column. The rectification section of the column is 1.5 m long and the stripping section is 1.2 m long. The boil up rate is fixed at 720 ml/minute. The liquid condensing in the rectification condenser is collected and comprises about 10% by weight of the roast and ground coffee.

35 A teaspoon of each soluble powder is dissolved in 150 ml of hot water at 85°C. All beverages produced have a brew-like flavour and aroma. Further, the

beverages are perceived to have more roastiness, body and balance than the beverages produced in example 1.

### Example 3

5

Roast and ground coffee is extracted, without stripping of the aroma prior to extraction, in a continuous extraction system made up of three extraction reactors and two solubilisation reactors. The extraction conditions are substantially identical to those of example 1. The extract obtained is then subjected to steam stripping in a stripping column in a conventional manner. The aromatised gas stream leaving the stripping column is condensed in a condenser operating under conditions substantially identical to those of the condenser of example 1.

The extract leaving the stripping column is concentrated to provide a concentrated extract containing above about 40% by weight of soluble coffee solids. The condensed liquid from the condenser is added to the concentrated extract and the extract is dried to soluble powder in a spray-drying tower.

A teaspoon of each soluble powder is dissolved in 150 ml of hot water at 85°C and the beverage analysed for aroma components. The results are as follows:

20

Sample	Aroma Count (cumulative equivalent $\mu\text{g/g}$ roast coffee)
Example 1, 15% strip, without frost	3.6
Example 1, 15% strip, with frost	6
Example 1, 30% strip, without frost	6
Example 1, 30% strip, with frost	8.5
Example 1, 90% strip, without frost	8.5
Example 1, 90% strip, with frost	18.5
Example 3	1.5

All soluble coffee beverages produced from the process of example 1 have higher aroma counts; even at low stripping rates. Further, the beverage produced from the powder of example 3 is perceived to have less flavour and aroma.

25

#### Example 4

The process of example 1 is repeated at a stripping rate of 40% by weight of steam compared to roast and ground coffee. The aromatised gas stream leaving the stripping column is then subjected to concentration by partial condensation. Two condensers are used; a first condenser operating at about 90°C to about 100°C and a second condenser operating at about 5° to about 15°C.

The liquid condensing in the first condenser contains primarily water and is disposed of. The liquid condensing in the second condenser is collected and comprises about 15% by weight of the roast and ground coffee.

The concentrated extract is freeze-dried instead of spray-dried to powder.

The aroma strength of a beverage produced from the powder of this example is compared to that of a beverage produced from the powder of example 3:

Sample	Aroma Count (cumulative equivalent µg/g roast coffee)
Example 4	4
Example 3	1.5

The beverage produced from the powder of this example has higher aroma counts. Further, the beverage produced from the powder of example 3 is perceived to have less flavour and aroma.

#### Example 5

The process of example 1 is repeated at a stripping rate of 40% or 90% by weight of steam compared to roast and ground coffee. The aromatised gas stream leaving the stripping column is then subjected to concentration by rectification in a packed rectification column. The rectification section of the column is 1.5 m long and the stripping section is 1.2 m long. The boil up rate is fixed at 720 ml/minute.

The liquid condensing in the rectification condenser is collected and comprises about 10% by weight of the roast and ground coffee.

The concentrated extract is either freeze-dried or spray-dried to powder.

The aroma strength of a beverage produced from the powder of this example is compared to that of a beverage produced from the powder of example 3:

Sample	Aroma Count (cumulative equivalent $\mu\text{g/g}$ roast coffee)
Example 5, spray-dried, 40% strip	4.4
Example 5, spray-dried, 90% strip	6.8
Example 5, freeze-dried, 90% strip	6.8
Example 3	1.5

5

The beverage produced from the powder of this example has much higher aroma counts. Further, the beverage produced from the powder of example 3 is perceived to have less flavour and aroma.

10 Example 6

Four commercially available coffee products are used:- a NESCAFÉ product purchased in the UK, a MAXWELL HOUSE product, a FOLGERS product and a KROGERS product; a soluble powder produced according to example 1 at 15% strip without frost addition, and each of the spray dried soluble powders of example 5. All products have been spray-dried. A teaspoon of each soluble powder is dissolved in 150 ml of hot water at 85°C and the beverage analysed for aroma components. The results are as follows:

15

Component	Example 1 (15% strip)	Example 5 (40% strip)	Example 5 (90% strip)	Nescafé® product	Maxwell House® product
Total Aroma	3.6	4.4	6.8	3.7	2.3
Furans	0.350	0.52	0.480	0.350	0.087
5-methyl-furfural	0.000	0.057	0.056	0.000	0.000
Diketones	0.37	0.38	0.26	0.18	0.030
2,3-hexane-dione	0.102	0.042	0.045	0.000	0.000
2-methyl-pyrazine	0.000	0.051	0.049	0.037	0.000

Component	Folgers® Product	Krogers® Product
Total Aroma	3.5	1.0
Furans	0.480	0.073
5-methyl-furfural	0.000	0.000
Diketones	0.090	0.00
2,3-hexane-dione	0.000	0.000
2-methyl-pyrazine	0.000	0.000

- 5 The beverages of examples 1 and 5 contain levels of total aroma and furans at least as high as beverages produced from the commercially available products. Further, the beverages of examples 1 and 5 contain at least 100% more diketones than the commercially available beverage with the next highest levels. Diketones are responsible for providing coffee beverages with buttery notes and are desirable. The beverages of examples 1 and 5 also contain detectable levels of
- 10 2,3-hexanedione while the other beverages do not.

Example 7

The process of example 1 is repeated at a stripping rate of 90% by weight of steam compared to roast and ground coffee. The aromatised gas stream leaving  
5 the stripping column is then subjected to concentration by freeze concentration.

The concentrated liquid leaving the freeze concentration system is collected and comprises about 10% by weight of the roast and ground coffee.

The aroma strength of a beverage produced from the powder of this example is compared to that of a beverage produced from the powder of example  
10 3:

Sample	Aroma Count (cumulative equivalent $\mu\text{g/g}$ roast coffee)
Example 7	11
Example 3	1.5

The beverage produced from the powder of this example has much higher aroma counts. Further, the beverage produced from the powder of example 3 is  
15 perceived to have less flavour and aroma.

Example 8

Five commercially available coffee products are used:- a NESCAFÉ GOLD  
20 product purchased in the UK, a MAXUM product, an ALTA RICA product, and a CARTE NOIRE product; a soluble powder produced according to example 5 at 90% strip with frost addition, a soluble powder produced according to example 5 at 90% strip without frost addition, a soluble powder produced according to example 5 at 60% strip without frost addition, a soluble powder produced  
25 according to example 5 at 40% strip without frost addition, and a soluble powder produced according to example 4 at 40% strip without frost addition. All products are freeze-dried.

A teaspoon of each soluble powder is dissolved in 150 ml of hot water at 85°C and the beverage analysed for aroma components. Further, roasted coffee  
30 beans are brewed in a commercial brew device to provide a beverage of substantially the same strength as the beverages produced from the soluble powders. The results are as follows:



Component	Brew	Example 5 (90% strip + Frost)	Example 5 (90% strip)	Example 5 (60% strip)	Example 5 (40% strip)
Total Aroma	12.1	9.5	6.8	3.3	4.8
Furans	3.250	2.230	0.910	0.700	0.770
5-methyl- furfural	0.114	0.117	0.118	0.071	0.069
Diketones	0.632	0.740	0.750	0.410	0.570
2,3-hexane- dione	0.110	0.112	0.102	0.050	0.073
2-methyl- pyrazine	0.112	0.092	0.082	0.052	0.053

Component	Example 4 (40% strip)	Nescafé® Gold product	Maxum® product	Alta Rica® Product	Carte Noir® Product
Total Aroma	4	2.7	3.2	3.3	3.0
Furans	0.720	0.350	0.590	0.300	0.370
5-methyl- furfural	0.064	0.000	0.000	0.000	0.000
Diketones	0.560	0.180	0.120	0.320	0.330
2,3-hexane- dione	0.066	0.000	0.000	0.047	0.043
2-methyl- pyrazine	0.044	0.000	0.000	0.000	0.000

5 The beverage produced by the powder of example 5 at 90% strip and with  
 frost addition has an aroma compound profile which is substantially identical to  
 that of brew coffee. Further, the beverage has a brew-like flavour and aroma.  
 All of the beverages produced from the powders of examples 4 and 5 have much  
 higher levels of furans, 5-methyl furfural, diketones, 2,3-hexanedione and 2-  
 methyl-pyrazine. The furans are responsible for providing beverages with toasted  
 10 notes and are highly desirable.

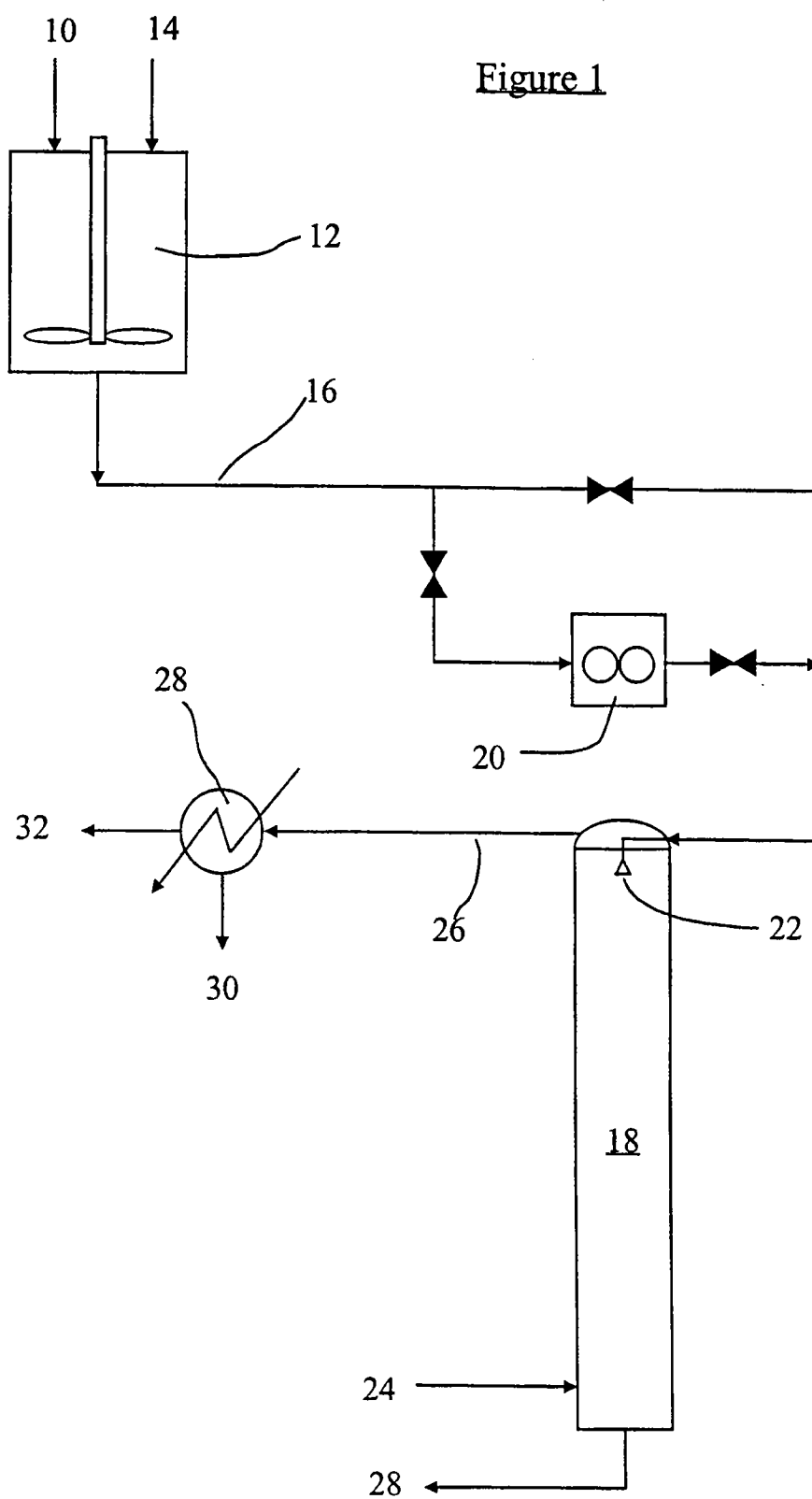
The beverages produced from the powders of examples 4 and 5 are perceived to have more brew-like flavour and aroma, roastiness, body and balance than the beverages produced from commercially available powders.

Claims

1. A process for the recovery of aroma components from coffee, the process comprising:
  - 5 providing a slurry of coffee grounds in an aqueous liquid;  
stripping aroma components from the slurry using gas in a substantially counter-current manner for providing an aromatised gas containing aroma components; and  
collecting the aroma components from the aromatised gas.
- 10 2. A process according to claim 1 in which the slurry of coffee grounds is provided by slurrying whole coffee beans with the aqueous liquid and then subjecting the coffee beans to wet grinding.
- 15 3. A process according to claim 1 in which the coffee grounds have an average particle size in the range of about 1 mm to about 3 mm.
- 20 4. A process according to claim 1 in which the aroma components are collected by subjecting the aromatised gas to, in a first operation, condensation at a temperature in the range of about 0°C to about 50°C and, in a second operation, to cryogenic condensation at a temperature of less than about -80°C.
- 25 5. A process according to claim 1 in which the aroma components are stripped from the slurry in a disc and donut stripping column.
6. A process according to claim 5 in which the gas used to strip the aroma components is at a gauge pressure of less than about 100 kPa.
- 30 7. An aromatised, spray-dried soluble coffee powder which comprises at least about 0.35 equivalent µg/g furans and at least about 0.25 equivalent µg/g diketones and which is produced by a process including the steps of:
  - providing a slurry of coffee grounds in an aqueous liquid;  
stripping aroma components from the slurry using gas in a substantially counter-current manner for providing an aromatised gas containing aroma components;  
35 collecting the aroma components from the aromatised gas;

- extracting soluble coffee solids from coffee grounds and concentrating the extracted soluble coffee solid for providing a concentrated coffee extract;  
combining the concentrated coffee extract and the collected aroma components for providing an aromatised extract; and  
5 spray-drying the aromatised extract for providing the aromatised coffee powder.
8. An aromatised, freeze-dried soluble coffee powder which comprises at least about 0.60 equivalent  $\mu\text{g/g}$  furans and at least about 0.40 equivalent  $\mu\text{g/g}$   
10 diketones and which is produced by a process including the steps of:  
providing a slurry of coffee grounds in an aqueous liquid;  
stripping aroma components from the slurry using gas in a substantially counter-current manner for providing an aromatised gas containing aroma components;  
15 collecting the aroma components from the aromatised gas;  
extracting soluble coffee solids from coffee grounds and concentrating the extracted soluble coffee solid for providing a concentrated coffee extract;  
combining the concentrated coffee extract and the collected aroma components for providing an aromatised extract; and  
20 freeze-drying the aromatised extract for providing the aromatised coffee powder.
9. An aromatised, spray-dried soluble coffee powder which comprises least about 0.35 equivalent  $\mu\text{g/g}$  furans and at least about 0.25 equivalent  $\mu\text{g/g}$   
25 diketones.
10. An aromatised, freeze-dried soluble coffee powder which comprises least about 0.60 equivalent  $\mu\text{g/g}$  furans and at least about 0.40 equivalent  $\mu\text{g/g}$  diketones.  
30

Figure 1



# INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/00747

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A23F5/48 A23F5/32 A23F5/34

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A23F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	FR 1 005 798 A (SOC. IMMOBILIÈRE ET FINANCIÈRE DU PARC) 22 April 1952 see page 1, column 2 - page 2, column 1; claims 1,2 ---	7,9
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X	EP 0 574 034 A (KRAFT GENERAL FOODS) 15 December 1993 see tables IIIB-IIIC ---	7-10
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

4 June 1999

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## INTERNATIONAL SEARCH REPORT

Internat: . Application No

PCT/EP 99/00747

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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